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Irregular Growth of Outplanted Red Pine
VI. The Influence of Handling and Planting on Fifth-Year Performance

by

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Previous notes (Pierpoint et al. 1977, 1978) reported the establishment and first- and second-year results of an outplanting experiment designed to determine whether nursery stock quality or handling and planting procedure was responsible for the irregular growth of red pine (*Pinus resinosa* Ait.) which had been observed in a number of field plantings. The performance of regular 3+0 red pine nursery stock, handled from the nursery and planted in the field with reasonable care by research staff, was tested and compared with the performance of similar stock handled and planted during normal district operations. The study showed generally good performance of the nursery stock in the research test plantings but a reduced survival, height growth and/or quality of leader in many district operations, attributable to handling and planting techniques.

This note reports and compares the fifth-year survival, height increment, total height and aggregate height of the research and district planted stock, and sketches some relationship between seedling quality after the first and second years in the field and subsequent growth to the fifth year.

Procedures

Eleven plantings were conducted during spring, 1976, in six districts; that is, on two dates in each of five districts and on one date in the sixth. Three 100-tree plots were located within each research and district planting. A full description of the experimental design and first- and second-year procedures was provided by Pierpoint et al. (1977, 1978). Fifth-year survival and height growth were measured in late 1980. Plot survival values with arc sine transformation, plot means of fifth-year (1980) height increment and total height and aggregate height were compared between district and research plantings by a t-test for unpaired plots.

Results and Discussion

The results for each planting are shown and compared in Table 1. After five growing seasons, district survival values were significantly lower than research survival values in eight of the eleven comparisons, were non-significantly lower in two comparisons, and were non-significantly higher in one comparison. Overall survivals were: District, 71.3%, Research, 88.3%. These figures indicate that survival decreased in twenty of the twenty-two plantings between the second and fifth years. The overall reduction in survival was 10% on district plots versus 5% on research plots, but locally it reached as high as 30% in the district plantings and 16% in the research plantings. These two heaviest mortalities occurred in the third growing season (1978)

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TABLE 1 Influence of handling and planting on survival and growth of 1976 outplanted red pine: fifth year results

Planting code[a]	Survival %	Mean height increment in fifth year cm	Mean total height end of fifth year cm	Aggregate height[b] m/ha	Difference[c] %
AKDE	83.0**	15.3	80.9	2014**	
AKRE	91.3	14.9	86.2	2361	17
AKDL	52.3**	3.8**	43.7**	686**	
AKRL	82.7	8.4	65.6	1628	137
BMDE	70.8**	22.3**	91.4*	1941**	
BMRE	97.3	28.4	110.2	3217	66
BMDL	74.2**	23.6	96.4**	2146**	
BMRL	97.0	25.4	110.4	3213	50
CKDL	82.5	32.3*	107.3**	2656	
CKRL	80.3	35.9	122.5	2951	11
HMDE	64.0**	12.3**	60.9**	1169**	
HMRE	90.0	16.9	77.0	2079	78
HMDL	49.7*	17.9*	71.8*	1071*	
HMRL	82.0	21.9	85.6	2106	97
LODE	75.4*	11.7	62.7*	1418*	
LORE	89.1	13.7	73.3	1959	38
LODL	89.0	16.9	76.4	2040	
LORL	91.7	17.5	83.0	2283	12
TODE	79.7	23.1	86.0	2056	
TORE	86.3	22.8	89.0	2304	12
TODL	64.0*	22.3	81.4*	1563	
TORL	83.7	25.0	96.5	2423**	55
	71.3 DISTRICT	GRAND TOTALS		DISTRICT 18760	
	88.3 RESEARCH			RESEARCH 26524	41

[a] Identifies planting - letters show district, nursery stock, handling and planting crew, planting time:

District		Nursery		Crew		Time	
A	Algonquin Park	M	Midhurst	D	District	E	Early
B	Blind River	O	Orono	R	Research	L	Late
C	Cornwall	K	Kemptville				
H	Huronia						
L	Lindsay						
T	Tweed						

[b] 3000 trees/ha x survival x mean total height.

[c] $\frac{\text{Research - District}}{\text{District}} \times 100$

* Significant at 95% probability.
** Significant at 99% probability.

at the same place and probably reflect the drier than normal summer season there, coupled with increasing competition from the on-site vegetation recovering from the initial site preparation. Mean height increment in the fifth year showed the district values to be less in nine of the eleven comparisons, with five of these differences being significant. It's worth realising that we are looking at the surviving trees and that significant differences in fifth-year height increment should not occur if these surviving trees are all well established, growing freely and reflecting the potential of the sites. Problems in handling and planting nursery stock obviously affect more than survival and have longer-term effects on the growth of the new stand. Remember that Mullin (1974) found planting effects on red pine stand volume that were significant after 20 years even though there had been no significant effects on survival or height growth.

The mean total height at the end of five growing seasons showed the district values to be lower in all comparisons, with eight of the eleven differences being significant. Total height after five years is an important parameter in plantation evaluation, indicating the likelihood of the new stand being able to grow freely ahead of competition.

Aggregate height is an expression of production achieved per unit area and combines survival and mean total height with the spacing of the trees. District aggregate height values in all comparisons were lower than the research values, and eight of the eleven comparisons were significant. The percent difference ranged from 11% to 137% with an overall difference of 41%.

At the end of the first growing season (1976) each surviving seedling was classified according to its leader and needle development (Pierpoint et al. 1977). The fifth-year (1980) survival and total height values are presented in Table 2 for these trees surviving in 1976, by quality class. Obviously, the quality class at the end of the first season did indicate the future performance of these seedlings.

TABLE 2 Seedling performance by 1976 quality classes

First-year quality class[a]	Fifth-year survival[a] %	Fifth-year mean total height cm
1	94	99.3
2	88	82.5
3	73	73.3

[a]of those trees surviving the first growing season.

At the end of the second season (1977) each tree then surviving was classified on the somewhat different basis of current (1977) needle-length as it was anticipated that the future performance would be related to this parameter (Fayle and Pierpoint 1978). Table 3 shows this to be so, both in survival and height growth.

The data on seedling quality class and subsequent growth obtained in this study have been augmented with data from later outplanting studies, and the whole subject of seedling quality as an indicator of subsequent development will be reported on in the near future.

The primary objective of all planting programs is to re-establish a desirable forest stand as quickly and economically as possible. Reduction in survival

and total height can delay this establishment and add additional costs if additional planting and tending are required.

TABLE 3 Seedling performance by 1977 needle classes

Second-year needle length[a] cm	Fifth-year survival[a] %	Third-year (1978) mean height increment[b] cm	Fifth-year mean total height cm
< 8	82	5.2	63.5
8-12	94	12.5	89.1
> 12	98	22.9	120.7

[a] of those trees surviving after 2 years.

[b] of those trees surviving after 5 years.

This study indicates that (1) nursery stock of the quality provided could survive and grow satisfactorily in the chosen planting sites when handled and planted with reasonable care, (2) the handling and planting procedures in use in field operations in 1976 did have a negative effect on both survival and growth, even after five years, and (3) early monitoring of seedling quality as well as survival is useful in forecasting the future development and success of the plantation.

Clearly, the challenge is to maintain the highest possible quality in handling and planting operations as well as in the production of nursery stock.

Acknowledgement

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